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Conjugate lateral eye movements in children.

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by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

The results of several studies (Bakan, 1969, 1971; Day, 1964; Duke, 1968; Libby, 1970, 1971) suggested a relation between cognitive processes and eye movements in adults. Cognitive processes were thought to occur when reflective questions were asked. The present study was concerned with the question whether there was a systematic change in looking behavior when reflective questions were asked, as a function of age. Background for this study was Piaget's (1962) proposal that change occurred in cognitive processes in children as a function of age. Subjects were, therefore, selected from ages suggested by Piaget (1962) as having the characteristics in cognitive processes of the pre-operational stage (2 - 7 years), the stage of concrete operations (7 - 12 years), and the stage of formal operations (11 - 12 years or above).

Differences in eye movements as a function of sex have been reported by Duke (1968). The present study also explored whether there were sex differences in children with regard to looking behavior. An equal number of male

and female subjects was selected in each age group.

In addition, it was investigated whether there was a relation between the dominance of hand, eye and foot, and looking behavior in children. Libby (1970) reported that no relation existed in adults between hand and eye dominance and eye movements.

Background of Related Literature

Conjugate lateral eye movements (CLEMs) are the joint movements of the eyes in a lateral direction. The movement can be further distinguished in the degree to which the movement is upward or downward. According to Day (1964), CLEMs are likely to occur after asking a person a reflective question. The person will momentarily break the shared gaze and turn his eyes away from the questioner. An instant later he will return his gaze and answer the question.

Day (1964) related the presence or absence of CLEMs to types of questions asked. Very simple questions of fact did not elicit eye movements, whereas questions that required some reflection were more likely to provoke the eye movement to occur. His observation that CLEMs are related

to cognitive processes has been supported by Duke (1968), Bakan (1969) and Libby (1970), in studies with reflective questions. Bakan (1969, 1971) proposed that the direction of "look-away" could be related to types of thinking. In a study with university students he found that left lookers tended to choose more of the so-called "soft majors" (e.g., psychology, political sciences, English. history, etc.). Bakan hypothesized that the cognitive processes of the left lookers should be more of a concrete, emotional, analogical and subjective nature. Right lookers had a tendency to choose "hard majors" (e.g.,mathematics, biology, engineering, economics, etc.). The "hard majors" students can be expected to be more abstract, rational, digital and objective in their cognitive processes.

Day (1964) also observed that the direction of "look-away" was fairly constant for the individual. His observation of consistency in the direction of CLEM has been supported by Duke (1968) who reported an average of 86 per cent. Bakan (1971) found an average of 75 per cent of "look-away" in one direction for his subjects.

It was Day's (1964) impression that CLEMs began to occur at approximately age three. His relation between cognitive processes and eye movements would therefore only apply to Piaget's (1962) last three stages of intellectual development, and not to the sensori-motor stage.

Duke (1968) found evidence of sex differences in the extent of individual consistency in preferring one direction of CLEMs over the other. The median split of intra-individual consistency divided the data between those individuals, regardless of sex, who showed perfect consistency and those who showed less-than-perfect consistency. It was found that males reflect the CLEMs phenomenon more consistently than did females. On the basis of these observations, Bakan (1971) hypothesized that sex differences are the result of a greater hemispheric integration in women than in men. To support this hypothesis, Bakan cites neurosurgical reports to the effect that women emerge from brain surgery in the left hemisphere with less severe speech impairment than do men. In addition, right hemispheric brain surgery seems to

impair the "art aptitude" less in women than in men.

With regard to dominance, Libby (1970) reported no relation between dominance of hand and eye and eye movements. Of interest in the present study is his comment on the fact that the direction of CLEMs was not associated with the dominance of hand or eye, nor with age, years in college, sex or income. He suggested that "look-away" in a particular direction must be learned somehow in the course of development.

Purpose of the Study

Until now, all studies concerned with CLEMs have dealt with adults. No study had been carried out so far to find out about the influence developmental aspects may have on looking behavior resulting from reflective states. The purpose of this study was to explore looking behavior in response to cognitive processes in children. Several questions arose as a result of this. For example, were there systematic changes in looking behavior between subjects in the last three stages of cognitive development proposed by Piaget (1962)? Included in looking behavior were the

occurrence and direction of eye and head movements. Subjects were selected from Kindergarten, Grade 4 and Grade 8.

With regard to sex, this study investigated whether there were differences between male and female subjects in the three age groups. Therefore, an equal number of boys and girls were selected in each age group.

It was also investigated whether there was a relation between the dominances of eye, hand and foot, and looking behavior.

Questions

The purpose of this study was to explore looking behavior in children during reflective states as a function of age and sex. The study was done to provide answers for the following questions:

1. Is there a systematic change in reaction times as a function of age and sex?

2. Is there a systematic change, as a function of age, in eye movements during reflective states?

3. Is there a systematic change, as a function of age, in head movements during reflective states?

4. Is there a systematic change, as a function of sex, in eye movements during reflective states?

5. Is there a systematic change, as a function of sex, in head movements during reflective states?

6. Is there any evidence for an interaction between age and sex in eye movements during reflective states?

7. Is there any evidence for an interaction between age and sex in head movements during reflective states?

8. Are the dominances of eye, hand and foot related to any of the aspects of looking behavior?

Method

Questionnaire

Forty questions were selected from a set of verbal items used by Laurendeau and Pinard (1962) in a causal thinking study (Appendix A). Subjects in their study ranged in age from 4 to 12 years. Sixteen of the questions were followed by "why" questions. In total, there were 56 instances in which eye and head movements could be observed.

The questions were used because, according to studies by Laurendeau and Pinard (1962) and Rourke (1966), children between the age of 4 and 12 will stop and think about the question before giving an answer. According to Duke (1968), these kinds of reflective questions increase the likelihood of eliciting CLEMs.

Subjects

Subjects for this study were 48 students from a public school in Windsor, Ontario. Of this group, 24 were female and 24 male. These were selected from three age groups so that there were 8 boys and 8 girls in each age

group. The first group had 16 students from Kindergarten with an average age of 5 years, 9 months. The second group had 16 students from Grade 4 with an average age of 9 years, 8 months. In the third group there were 16 students from Grade 8 with an average age of 13 years, 5 months.

Conditions for selection were the following:

1. Subjects were Canadian-born children whose native language was English.

2. Subjects had made normal progress in school.

3. Subjects had no severely debilitating physiological or psychological disturbances or disorders.

Information about these conditions was received from the school with the understanding that it would be kept confidential. During recruitment, no mention was made as to the precise nature of the study. Subjects were informed that questions would be asked in order to study their ideas about some concepts.

The Experiment

Each subject was given the questionnaire during a

testing session which lasted approximately 25 minutes. Before the questionnaire was administered, the subject's eye, hand and foot dominance were determined by means of a questionnaire for dominance (Appendix D). The whole session was videotaped in a research trailer in order to allow for objective scoring and to have a standard testing environment.

Observations

The following observations were made on each subject.

1. The total number of first eye movements after the question was asked, which divided into the number of CLEMs in the upward and downward direction and the number of CLEMs in the right and left direction.

2. Whether or not there were eye movements during the asking of the question.

3. The total number of first head movements after the question was asked, divided into head movements in the upward and downward direction and head movements in the right and left direction.

4. Whether or not there were head movements during the asking of the question.

5. For each question, the reaction time of the first eye movement after the question was recorded.

6. For each question, the reaction time of the verbal response was scored.

Procedure

Upon entering the trailer, the subject was first given the questionnaire to determine his eye, hand and foot dominance. After this, the female experimenter told the subject that this was not a test of ability, so that the subject would feel more at ease.

The subject was seated in front of a table approximately 5 feet from the wall with the screen on it. The experimenter was sitting behind the table (see Figure 1, p.12 and Figure 2, p.13).

Behind the screen a Sony Video Camera (type D x C - 2000 A) with a Sony electronic viewfinder and zoomlens (f = 16-64 mm) was used to record a close-up picture of the subject's face. The camera was connected with a Sony

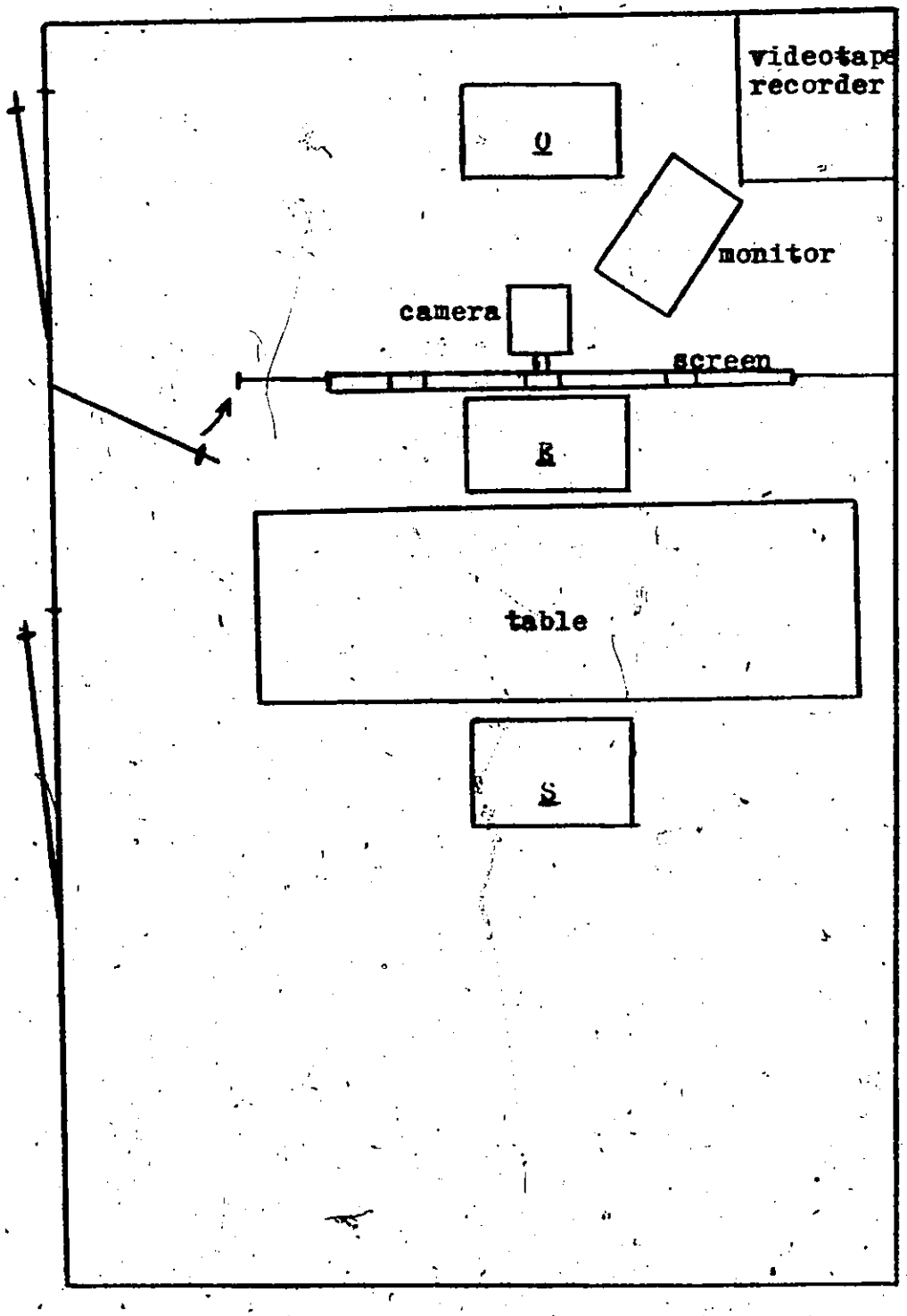


Figure 1. The experimental setting (bird view)

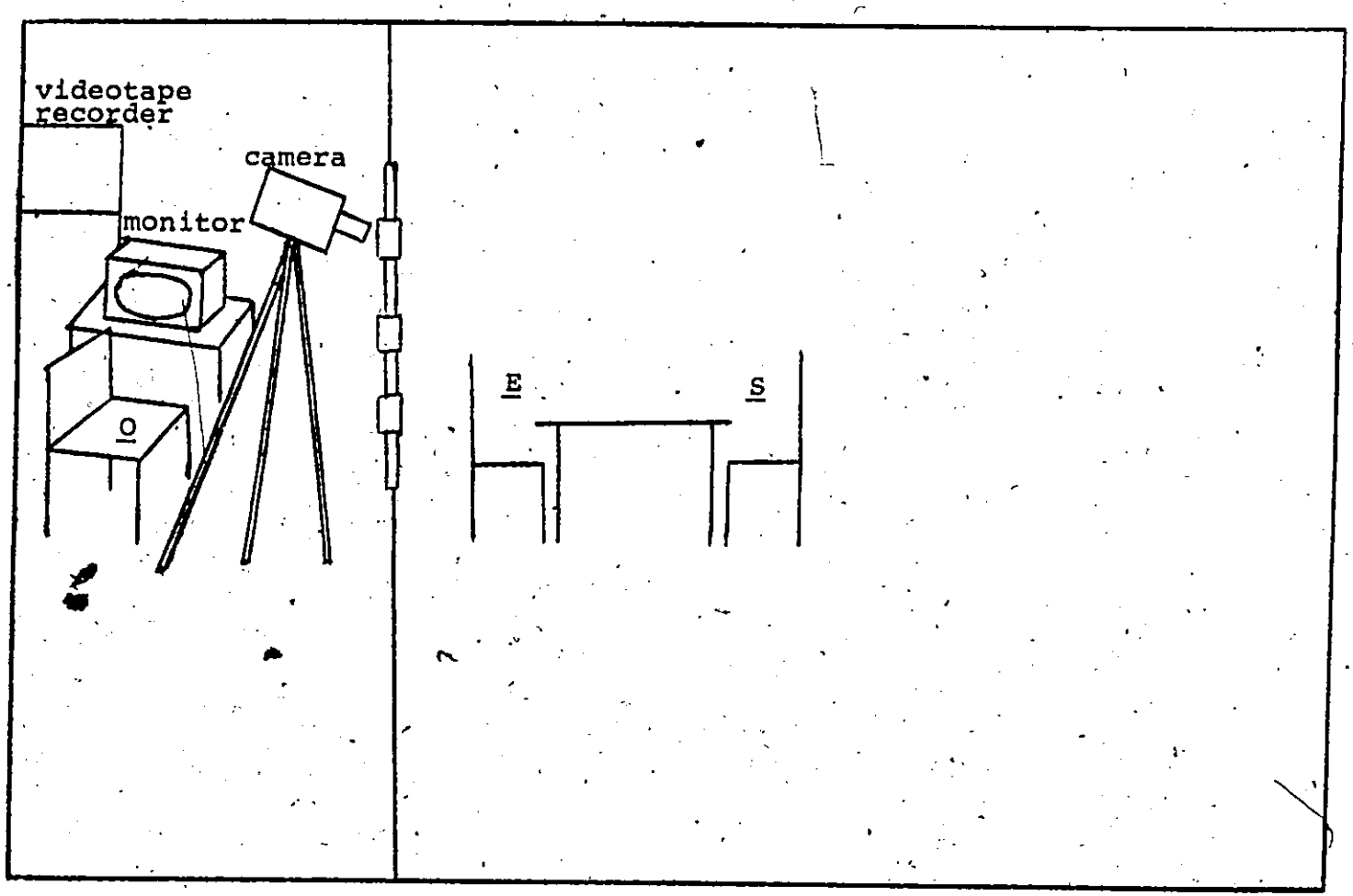


Figure 2. The experimental setting (profile)

videorecorder (type AV 3650). On a Sony transistor video monitor (model CVM - 110UA), the observer could see what was put on the videotapes and, if necessary, could correct the camera. Sound was transmitted by way of an Electrovoice (type 635A) dynamic omnidirectional microphone which was hidden under the table.

After reading the instructions (Appendix C), the experimenter began with the questionnaire. To make sure the subject was looking at the experimenter, she would tell the subject to look at her every time before she asked a question. After the questionnaire was completed, the subject was thanked and sent back to his (her) classroom.

Scoring and Analysis of the Data

Four subjects had to be replaced during the testing period: one because of mechanical failure of the audio; three had to be replaced because of their absence during the testing period.

From the videotape recordings, eye and head movements were scored by at least two independent scorers (Appendix B).

For the analysis of data, items were used after a second review of the videotape recordings and all scorers were in agreement. Eye movements and head movements made during the asking of the question were not included in the analysis of data. Eye response and verbal response reaction times were recorded separately with at least two stopwatches.

Results

The following computations of the raw data were carried out for each subject:

1. The total number of first eye and first head movements during reflective states.

2. The total number of eye movements in the upward and downward directions.

3. The total number of right and left eye and head movements.

4. The average reaction times for the first eye movements and the verbal responses.

5. Percentages of up/down and right/left eye and head movements. These percentages were calculated as in the following example. For example, if there were 30 eye movements in upward and 10 eye movements in downward direction, this yielded (30 U) / (30 U + 10 D) x 100 = 75.0 per cent upward eye movements. 20 CLEMs to the right and 30 CLEMs to the left yielded (30 L) / (20 R + 30 L) x 100 = 60.0 per cent left CLEMs.

Sixteen two-way analyses of variance (one for each dependent variable) were carried out. The main effects in these analyses were age and sex. Pearson product moment correlations were calculated between the dominances of eye, hand and foot and eight of the sixteen dependent variables.

Internal Consistency

To determine the degree of internal consistency, Pearson product moment correlations were calculated between odd and even questions on 12 dependent variables. For this purpose, the upward and downward and the right and left eye and head movements were combined (Table 1). All correlations were significant beyond the .01 level. Since 23 of the 32 correlations were .80 or higher, it was concluded that there was a high degree of internal consistency in the data.

Interscorer Reliability

The videotapes were observed by at least two scorers. Initial disagreement was obtained in 2,592 of the 26,880 responses. The bulk of the disagreements involved the reaction time measures. In the analysis of data, only those items were

TABLE 1

PEARSON PRODUCT MOMENT CORRELATIONS AMONG LOOKING RESPONSES TO ODD AND EVEN QUESTIONS IN PRESENTATION ORDER (N = 28)

	VARIABLE NUMBER	VARIABLE NAME	SUBJECT GROUP	VARIABLE NUMBER 1	2	3	4	5	6	7	8
ODD QUESTIONS	1	MAINTAINED EYES	ALL	.887							
			KINDER-GARTEN	.901							
			GRADE 4	.633							
			GRADE 8	.586							
	2.	UP/DOWN EYES	ALL		.871						
			KINDER-GARTEN		.921						
			GRADE 4		.860						
			GRADE 8		.862						
	3.	RIGHT/LEFT EYES	ALL			.893					
			KINDER-GARTEN			.776					
			GRADE 4			.911					
			GRADE 8			.906					
EVEN QUESTIONS	4	REACTION TIME EYES	ALL				.872				
			KINDER-GARTEN				.899				
			GRADE 4				.889				
			GRADE 8				.847				
	5	MAINTAINED HEAD	ALL					.906			
			KINDER-GARTEN					.982			
			GRADE 4					.865			
			GRADE 8					.745			
	6	UP/DOWN HEAD	ALL						.758		
			KINDER-GARTEN						.860		
			GRADE 4						.757		
			GRADE 8						.502		
	7	RIGHT/LEFT HEAD	ALL							.848	
			KINDER-GARTEN							.783	
			GRADE 4							.863	
			GRADE 8							.871	
	8	REACTION TIME VERBAL RESPONSE	ALL								.858
			KINDER-GARTEN								.773
			GRADE 4								.910
			GRADE 8								.973

NOTE: All correlations are significant beyond the .01 level

used on which scorers were in complete agreement. Effectively, a perfect interscorer reliability was obtained by repeated observation of the videotapes with at leas[redacted] scorers.

Effects of Age and Sex on Reaction Times

1. Is there a systematic change in reaction times as a function of age and sex?

TABLE 2

MEANS* AND STANDARD DEVIATIONS FOR FIRST EYE MOVEMENT REACTION TIMES FOR BOYS AND GIRLS IN KINDERGARTEN, GRADE 4, AND GRADE 8

			AGE GROUP		
			KINDERGARTEN	GRADE 4	GRADE 8
S	BOYS	M:	0.74	0.75	0.70
E		s:	0.70	0.67	0.44
X	GIRLS	M:	0.71	0.61	0.60
		s:	0.76	0.45	0.48

*NOTE: Means are in seconds.

Included in Table 2 are the means and standard deviations for the reaction times of the first eye movements. There was a slight decrease in reaction time with increase

in age. Girls had a tendency to have shorter reaction times than did boys. With respect to the variable of the first eye movement reaction time, a two-way analysis of variance yielded an interaction F of 0.3109, df = 2/45; this was not significant ($p > .10$). It may be that any change in this measure with age was essentially the same for boys and girls.

TABLE 3

MEANS* AND STANDARD DEVIATIONS OF VERBAL RESPONSE REACTION TIMES FOR BOYS AND GIRLS IN KINDERGARTEN, GRADE 4, AND GRADE 8

			AGE GROUP		
			KINDERGARTEN	GRADE 4	GRADE 8
S	BOYS	M:	3.64	4.43	3.51
E		s:	3.33	4.59	2.76
X	GIRLS	M:	3.07	3.99	4.22
		s:	4.40	4.11	3.84

*NOTE: Means are in seconds

Included in Table 3 are the means and standard deviations for the verbal response reaction times for boys and girls in Kindergarten, Grade 4, and Grade 8. No remarkable

difference occurred in the average verbal response reaction time as a function of age or sex. The average reaction time (range: 3 - 4.4 seconds) could be an indication that most questions elicited reflective activity. With respect to the variable of verbal reaction time, a two-way analysis of variance yielded an interaction F of 0.4773, df = 2/45; this was not significant ($p > .10$). It may be that any change in this measure with age was essentially the same for boys and girls.

Effects of Age on Eye and Head Responses

2. Is there a systematic change, as a function of age, in eye movements during reflective states?

Included in Table 4 are the means and standard deviations for eye responses in Kindergarten, Grade 4, and Grade 8. The decrease in the average number of times that eye contact was maintained indicated that more eye movements were made with increase in age. A two-way analysis of variance was carried out. The F ratio for the average number of times eye contact was maintained was 15.25, df = 2/45; this was statistically significant ($p < .001$).

It may be that there was a significant difference in the number of times eye contact was maintained between the different age groups. A decrease of about 61 per cent appeared from Kindergarten to Grade 4 for "maintained" eye movements. With respect to the variable of left CLEMs, a two-way analysis of variance gave an F of 5.91, df = 2/45; this was statistically significant ($p < .01$). It would appear that in the three age groups there is a different development with regard to left CLEMs.

TABLE 4

MEANS AND STANDARD DEVIATIONS OF EYE RESPONSES IN AGE GROUPS: KINDERGARTEN, GRADE 4, GRADE 8

VARIABLE NAME		AGE GROUP		
		KINDERGARTEN	GRADE 4	GRADE 8
MAINTAINED	M:	15.06	5.81	5.00
	s:	10.16	3.27	3.50
UP	M:	15.81	16.38	22.19
	s:	11.05	10.50	11.62
DOWN	M:	15.69	16.81	14.63
	s:	9.15	8.58	11.49
RIGHT	M:	20.31	17.88	15.69
	s:	12.31	13.61	12.72
LEFT	M:	18.50	29.31	33.13
	s:	8.46	15.27	15.03
% UP/DOWN	M:	70.3	69.5	72.7
	s:	12.9	13.9	14.0
% RIGHT/LEFT	M:	67.8	77.8	77.7
	s:	11.0	13.2	16.3

The percentage of right/left CLEMs increased by 10 per cent between Kindergarten and Grade 4. Almost no change was found between Grade 4 and Grade 8. A two-way analysis of variance was carried out. The F ratio for the percentage of right/left CLEMs was 3.15, df = 2/45; this was statistically significant ($p < .10$). It may be that there was a significant change in the percentage of right/left CLEMs as a function of age.

3. Is there a systematic change, as a function of age, in head movements during reflective states?

Included in Table 5 are the means and standard deviations for head responses in Kindergarten, Grade 4, and Grade 8. There appeared to be a general tendency to keep the head steadier as age increased. With respect to "maintained head", a two-way analysis of variance, with age as independent variable, yielded an F of 1.38, df = 2/45; this was not significant ($p > .10$).

Upward, downward and right head movements had a tendency to decrease with an increase in age. A two-way

analysis of variance was carried out. The F ratios for upward, downward and right head movements were respectively 0.07; 1.90; and 1.88, df = 2/45; these were not statistically significant ($p > .10$). It would appear that changes in these measures were essentially the same in the three age groups.

TABLE 5

MEANS AND STANDARD DEVIATIONS OF HEAD RESPONSES IN AGE GROUPS: KINDERGARTEN, GRADE 4, GRADE 8

		AGE GROUP		
VARIABLE NAME		KINDERGARTEN	GRADE 4	GRADE 8
MAINTAINED	M:	30.75	34.19	39.75
	s:	18.92	15.04	10.47
UP	M:	8.56	8.25	7.44
	s:	10.79	8.37	5.66
DOWN	M:	4.32	4.13	2.25
	s:	3.63	3.59	3.21
RIGHT	M:	13.00	9.50	6.00
	s:	12.03	9.72	7.47
LEFT	M:	10.06	10.19	8.94
	s:	7.34	9.30	8.83
% UP/DOWN	M:	83.5	60.6	76.2
	s:	14.4	27.4	27.0
% RIGHT/LEFT	M:	69.3	73.9	72.6
	s:	17.3	16.2	24.6

The consistency with which subjects turned their head up or down showed a drop of almost 23 per cent between Kindergarten and Grade 4, and an increase of 16 per cent between Grade 4 and Grade 8. The F ratio for the percentage of upward or downward head movements was 3.72, df = 2/45; this was significant ($p < .05$). It appeared that the subjects in the three age groups develop differently with respect to "per cent up/down" head movements.

Effects of Sex on Eye and Head Responses

4. Is there a systematic change, as a function of sex, in eye movements during reflective states?

Included in Table 6 are the means and standard deviations of eye responses for boys and girls.

Girls maintained eye contact more often than did boys. The F ratio for maintaining eye contact in the two-way analysis of variance was 8.26, df = 1/46; this was statistically significant ($p < .01$). This would indicate that boys made more eye movements than did girls.

With respect to the variable of downward eye movements, a two-way analysis of variance with sex as independent variable

TABLE 6

MEANS AND STANDARD DEVIATIONS OF EYE RESPONSES FOR BOYS AND GIRLS

VARIABLE NAME		MALE	FEMALE
MAINTAINED	M:	6.25	11.00
	s:	5.88	8.91
UP	M:	18.46	17.79
	s:	12.17	10.42
DOWN	M:	19.13	12.29
	s:	11.08	6.58
RIGHT	M:	19.63	16.29
	s:	13.38	12.16
LEFT	M:	26.88	27.08
	s:	15.43	13.72
% UP/DOWN	M:	72.8	68.8
	s:	14.1	12.7
% RIGHT/LEFT	M:	74.6	74.3
	s:	14.3	14.3

yielded an F of 6.45, df = 1/46; this was statistically significant ($p < .05$). This would indicate that boys made more downward eye movements than did girls. Although there was a tendency for boys to make more right CLEMs than girls, the F ratio for right CLEMs was 0.92, df = 1/46; this was not significant ($p > .10$).

In the percentage of look-away to one direction,

boys had the tendency to look more consistently upward or downward than did girls. A two-way analysis of variance was carried out. The F ratio for the percentage of upward or downward eye movements was 0.95, df = 1/46; this was not significant ($p > .10$). It is possible that any change in this measure was essentially the same for boys and girls.

5. Is there a systematic change, as a function of sex, in head movements during reflective states?

Included in Table 7, are the means and standard deviations of head responses for boys and girls.

With respect to downward head movements, a two-way analysis of variance yielded an F of 6.60, df = 1/46; this was statistically significant ($p < .05$). It appeared that boys made significantly more downward head movements than did girls.

With respect to the variable of "maintained" head, a two-way analysis of variance yielded an F of 0.37, df = 1/46; this was not statistically significant ($p > .10$). It may be that any change in this measure was essentially the same for boys and girls.

In turning their head to one direction, boys tended to be less consistent in either upward or downward head movements than girls. A two-way analysis of variance yielded an F of 1.01, df = 1/46; this was not significant ($p > .10$). It may be that with respect to "per cent up/down" head movements boys and girls did not differ.

TABLE 7

MEANS AND STANDARD DEVIATIONS OF HEAD RESPONSES FOR BOYS AND GIRLS

VARIABLE NAME		MALE	FEMALE
MAINTAINED	M:	33.54	36.25
	s:	13.09	17.49
UP	M:	7.46	8.71
	s:	6.73	9.84
DOWN	M:	4.79	2.33
	s:	3.68	2.97
RIGHT	M:	9.58	9.42
	s:	8.44	11.76
LEFT	M:	10.54	8.92
	s:	8.09	8.74
% UP/DOWN	M:	69.9	77.0
	s:	21.9	28.0
% RIGHT/LEFT	M:	71.5	72.4
	s:	17.3	21.7

Interaction of Age and Sex

6. Is there any evidence for an interaction between age and sex in eye movements during reflective states?

Included in Table 8 are the means and standard deviations of eye responses for boys and girls in Kindergarten, Grade 4, and Grade 8.

The number of times that eye contact was maintained decreased with increase in age for boys as well as for girls. For the variable of "maintained" eyes, a two-way analysis of variance gave an interaction F of 3.74, df = 2/45; this was statistically significant ($p < .05$). It appeared that in this measure with age boys and girls developed differently with respect to "maintained" eyes.

The number of upward eye movements increased for boys with increase in age. For girls, the number of upward eye movements decreased in Grade 4 and increased sharply in Grade 8. With respect to the variable of upward eye movements, a two-way analysis of variance yielded an interaction F of 0.69, df = 2/45; this was not significant ($p > .10$). It may be that any change in this measure with

TABLE 8

MEANS AND STANDARD DEVIATIONS OF EYE RESPONSES IN AGE GROUPS: KINDERGARTEN, GRADE 4, GRADE 8

VARIABLE NAME			AGE GROUP		
			KINDERGARTEN	GRADE 4	GRADE 8
MAINTAINED	BOYS	M:	9.50	5.25	4.00
		s:	8.50	3.58	3.12
	GIRLS	M:	20.63	6.38	6.00
		s:	8.85	3.07	3.78
UP	BOYS	M:	16.00	19.13	20.25
		s:	12.02	12.05	13.64
	GIRLS	M:	15.63	13.63	24.13
		s:	10.82	8.58	9.75
DOWN	BOYS	M:	19.25	18.13	20.00
		s:	9.32	10.56	14.25
	GIRLS	M:	12.13	15.50	9.25
		s:	7.97	6.50	3.73
RIGHT	BOYS	M:	24.13	24.50	10.25
		s:	13.73	11.36	10.95
	GIRLS	M:	16.50	11.25	21.13
		s:	10.16	12.95	12.63
LEFT	BOYS	M:	18.75	22.38	39.88
		s:	11.07	13.93	13.60
	GIRLS	M:	18.25	36.25	26.75
		s:	5.55	14.00	14.36
% UP/DOWN	BOYS	M:	70.5	72.6	75.1
		s:	14.7	14.6	14.5
	GIRLS	M:	70.1	66.3	70.2
		s:	11.9	13.3	14.1
% RIGHT/LEFT	BOYS	M:	70.8	70.5	82.5
		s:	14.1	11.7	15.3
	GIRLS	M:	64.8	85.2	73.0
		s:	6.2	10.6	16.9

age was essentially the same for boys and girls.

Girls had less downward eye movements than had boys. Of interest was that boys had twice as many downward eye movements than had girls in Grade 8. With respect to the variable of downward eye movements, a two-way analysis of variance yielded an interaction F of 0.76, df = 2/45; this was not significant ($p > .10$). It is possible that any change in this measure with age was essentially the same for boys and girls.

While boys had a decrease of almost 66 per cent in the number of right CLEMs between Grade 4 and Grade 8, girls had an increase of almost 88 per cent. For the variable of right CLEMs, a two-way analysis of variance gave an interaction F of 4.41, df = 2/45; this was statistically significant ($p < .05$). It may be that boys and girls develop differently with respect to right CLEMs.

Boys increased in the number of left CLEMs with increase in age. Girls had an increase between Kindergarten and Grade 4, but decreased in Grade 8. With respect to the variable of left CLEMs, a two-way analysis of variance

yielded an interaction F of 4.56, df = 2/45; this was statistically significant ($p < .05$). It is possible that the change in this measure with age was essentially different for boys and girls.

Boys were more consistent in looking away to the right or to the left in Kindergarten and Grade 8 than were girls. In Grade 4, girls were more consistent than boys. For the variable of "per cent right/left CLEMs", a two-way analysis of variance yielded an interaction F of 4.09, df = 2/45; this was statistically significant ($p < .05$). It may be that boys and girls develop differently with respect to percentage of right/left CLEMs.

7. Is there any evidence for an interaction between age and sex in head movements during reflective states?

Included in Table 9 are the means and standard deviations of head responses for boys and girls in Kindergarten, Grade 4, and Grade 8.

Girls in Grade 8 had considerably less head movements than had boys. With respect to the variable "maintained" head,

TABLE 9

MEANS AND STANDARD DEVIATIONS OF HEAD RESPONSES IN AGE GROUPS: KINDERGARTEN, GRADE 4, GRADE 8

VARIABLE NAME			AGE GROUP		
			KINDERGARTEN	GRADE 4	GRADE 8
MAINTAINED	BOYS	M:	30.50	35.13	35.00
		s:	13.38	16.68	9.47
	GIRLS	M:	31.00	33.25	44.50
		s:	24.24	14.31	9.67
UP	BOYS	M:	5.75	7.75	8.88
		s:	6.30	8.97	4.79
	GIRLS	M:	11.38	8.75	6.00
		s:	13.85	8.31	6.39
DOWN	BOYS	M:	5.50	4.75	4.13
		s:	4.00	3.73	3.68
	GIRLS	M:	3.13	3.50	0.38
		s:	3.00	3.59	0.74
RIGHT	BOYS	M:	13.88	10.25	4.63
		s:	8.61	8.32	6.39
	GIRLS	M:	12.13	8.75	7.38
		s:	15.31	11.49	8.63
LEFT	BOYS	M:	9.50	7.63	14.50
		s:	5.71	7.95	9.50
	GIRLS	M:	10.63	12.75	3.38
		s:	9.07	10.36	2.50
% UP/DOWN	BOYS	M:	82.7	55.6	71.6
		s:	14.5	25.5	16.9
	GIRLS	M:	84.3	65.7	80.8
		s:	15.3	30.0	35.0
% RIGHT/LEFT	BOYS	M:	66.2	66.8	81.4
		s:	17.3	16.6	15.5
	GIRLS	M:	72.5	81.1	63.8
		s:	18.0	13.1	29.7

a two-way analysis of variance yielded an interaction of 0.60, df = 2/45; this was not significant ($p > .10$). It appears that any change in this measure with age was essentially the same for boys and girls.

Girls had more left head movements in Kindergarten and Grade 4 than boys. Boys, however, had considerably more left head movements in Grade 8. For the variable of left head movements, a two-way analysis of variance gave an interaction F of 4.51, df = 2/45; this was statistically significant ($p < .05$). It may be that boys and girls develop differently with respect to left head movements.

Of interest is the decrease in consistency to turn the head upward or downward for both boys and girls between Kindergarten and Grade 4, followed by an increase for both boys and girls in Grade 8. With respect to the variable of "per cent up/down" head movements, a two-way analysis of variance yielded an interaction F of 0.15, df = 2/45; this was not significant ($p > .10$). It is possible then that any change in this measure with age was essentially the same for boys and girls.

Boys did not change much in consistency to turn the head to the right or to the left between Kindergarten and Grade 4. However, there was a considerable increase in Grade 8. Girls increased their consistency considerably for right or left head movements between Kindergarten and Grade 4, and decreased in Grade 8. For the variable of "per cent right/left" head movements, a two-way analysis of variance gave an interaction F of 3.01, df = 2/45; this was statistically significant ($p < .10$). It may be that boys and girls developed differently with respect to "per cent right/left" head movements.

Dominances

8. Are the dominances of eye, hand and foot related to any of the aspects of looking behavior?

Included in Table 10 are the correlation coefficients among the dominances of eye, hand and foot and eight variables of looking behavior over all subjects combined, and subjects in Kindergarten, Grade 4, and Grade 8 separately.

TABLE 10

PEARSON PRODUCT MOMENT CORRELATION AMONG THE DOMINANCES OF EYE, HAND AND FOOT AND EIGHT LOOKING VARIABLES OVER ALL SUBJECTS (N = 48) AND SUBJECTS IN KINDERGARTEN, GRADE 4, AND GRADE 8 (N = 16)

		VARIABLES							
		EYES					HEAD		
DOMINANCE	SUBJECT GROUP	MAINTAINED	UP	DOWN	RIGHT	LEFT	MAINTAINED	UP	RIGHT
EYE	ALL	.070	-.161	.071	.077	-.131	-.085	-.082	.144
	KINDERGARTEN	.286	-.240	-.170	-.220	-.006	.367	-.306	-.393
	GRADE 4	-.101	.013	.216	-.286	-.273	-.439	.059	.643*
	GRADE 8	-.000	-.141	.284	-.006	.023	-.404	.177	.366
HAND	ALL	-.158	.053	.033	-.080	.193	.009	-.105	.005
	KINDERGARTEN	-.264	.366	-.137	-.223	.678*	-.293	.209	.133
	GRADE 4	-.002	.086	-.117	-.060	.126	.354	-.413	-.177
	GRADE 8	-.000	-.141	.284	-.006	.023	-.404	.177	.366
FOOT	ALL	-.017	.193	-.127	.102	-.155	.210	-.194	-.122
	KINDERGARTEN	-.012	.094	.089	.034	-.252	.307	-.270	-.307
	GRADE 4	-.368	.557*	-.493**	.162	-.092	.314	-.272	-.097
	GRADE 8	.228	.065	-.015	-.014	-.144	-.019	.309	-.036

* Significant beyond the .01 level
**Significant beyond the .05 level

NOTE: Only those variables with the highest correlations were included.

Pearson product moment correlations were calculated between the three dominances and all dependent variables. In Table 10 only those variables were included with the highest correlations. No significant correlations were found between eye, hand and foot dominances and the dependent variables in the All category.

In Kindergarten a significant ($p < .01$) correlation was found between hand dominance and left CLEMs. In Grade 4, eye dominance and right head movements had a significant ($p < .01$) correlation. There was also a significant ($p < .01$) correlation between foot dominance and upward eye movements. Foot dominance had also a significant ($p < .05$) negative correlation with downward eye movements. Since only four of the 96 correlation coefficients in Table 10 are significant, it is quite probable that these significant correlations emerged solely as the result of chance factors.

Discussion

The results of this explorative study included some aspects of the development of looking behavior in children when reflective questions were asked. Systematic as well as non-systematic changes were found as a function of age and sex or interaction between age and sex. In general, it was observed that eye movements occurred more frequently than did head movements.

With regard to age, a tendency existed to increase eye movements and to decrease head movements with increase in age. When eye movements increased, they tended to go more to the left than to the right. Previous studies did not mention any preference for a particular direction of look-away with regard to the type of questions asked. It is assumed that a relation could exist between the content of the questions and the preference for left CLEMs. If the questions used in this study would provoke abstract thinking, then, according to Bakan's (1969, 1971) proposition, these should elicit more right CLEMs. Yet it was found that there were more left CLEMs. The question remains whether these questions were of an abstract nature or whether there were

other aspects influencing the looking behavior.

The increase in the number of left CLEMs with increase in age mirrors Piaget's development of cognitive structures. If the number of left CLEMs is related to cognitive development in children, it may be that, in response to these types of questions, there will be an increase in left CLEMs with further increase in age until a certain asymptote has been reached. Further research will be needed to investigate the proposed relation between eye movements and cognitive development.

Upward, downward and right head movements showed little change between Kindergarten and Grade 4. With regard to direction, the number of head movements decreased mostly in Grade 8. Head movements did not show significant correlation with eye movements. During the experimental session, it was observed that head movements usually occurred after the first eye movement. Furthermore, no significant correlation was found between the direction of the first eye movements and the direction of the following head movements.

Boys made significantly more eye movements than did girls. This could mean that the questions used provoked reflective states more readily in boys than in girls. It was

also found that boys had significantly more eye movements and head movements in the downward direction than did girls. According to Libby (1971), "people tend to look down more... when they are required to express their own opinion...". This suggests that boys tended to feel more often than girls that it was required of them to express their own opinion.

If the number of times eye contact is maintained can be taken as an index of social immaturity (Libby, 1971), then boys in Kindergarten would be socially more immature than girls. However, Day's (1964) proposition that less eye movements will occur when the anxiety level is high, would indicate that girls were more frightened by the experimental situation than were boys. Another aspect which could have had its influence on the looking behavior was the sex of the experimenter who asked the questions. It is possible that boys reacted differently to the female experimenter than did girls. This should be taken into account when further research is done in this field.

Of interest was the change in Grade 8 for boys and girls in the number of right and left CLEMs. While boys decreased their number of right CLEMs and increased in

left CLEMs, girls had an increase in the number of right CLEMs and a decrease in the number of left CLEMs. If the content of questions is of influence in the direction of look-away, do boys perceive this content differently than do girls in Grade 8? Since a relatively small number of subjects was used in this study, it is difficult to generalize these findings. Further research should pay attention to this difference in order to find out whether it is of importance.

With regard to reaction times, no significant change was found as a function of age and sex. This would indicate that neither age nor sex had any effect on reaction times of either eye movement or verbal response. It would be interesting to know whether different types of questions would have effect on either or both reaction times.

The consistency with which subjects moved their eyes in one direction did not show a systematic change as a function of age.

No significant correlations were found between the dominances of eye, hand and foot, and eight looking variables. This indicated that no relation existed between

dominances of eye, hand and foot, and looking behavior, in the present study. Since, however, the content of the questions could have had its influence on the direction of look-away, no conclusion could be derived from this finding.

Finally, it must be clear that there could be many more aspects and areas related to looking behavior resulting from reflective states. Many of these aspects merit investigation.

Summary

An attempt was made to explore looking behavior that occurred during reflective states in 48 children. Reflective states were elicited on 56 instances by means of questions.

It was found that, with increase in age, children tended to have more eye movements, as opposed to head movements which tended to decrease with increase in age. It was also found that there were significantly more CLEMs to the left than to the right. It was thought that the content of the questions may have been the principal factor affecting the direction of look-away.

Sex differences appeard mainly in the number of times eye contact was maintained. This was especially true of boys in Kindergarten who maintained eye contact less than did girls. It was assumed that the anxiety level in Kindergarten, especially with girls, was higher than normal, so that, according to Day's (1964) proposition, less eye movements occurred.

The boys exhibited significantly more downward eye movements than did girls. It is possible that boys reacted

in a different way to the female experimenter than did girls.

No significant changes were found in reaction times for eye movements and verbal responses. It appeared that age and sex did not have an effect on the reaction times.

There were no clear systematic changes in the directionality of eye movements for boys and girls. It is possible that there were too few subjects in this study to reflect this trend.

Eye, hand and foot dominances were not related to the direction of CLEMs or to looking behavior in general. However, this result could have been caused by the proposed effect of the content of the questions.

APPENDIX A

QUESTIONNAIRE

QUESTIONNAIRE

1. Tell me, what is a dream?
2. Is a mountain alive? Why?
3. Why is it dark at night?
4. Where does the sun come from?
5. Is the earth alive? Why?
6. Where does a dream come from?
7. Is a bell alive? Why?
8. Where does the dark come from at night?
9. Is the sun always there during the daytime? Why?
10. What makes the earth move?
11. While you are dreaming, where is your dream?
12. Is the wind alive? Why?
13. Is it dark when we sleep during the daytime? Why?
14. Can we make the night in this room? Why?
15. Where does water come from?
16. If I were in your room, could I see your dream? Why?
17. Is a fish alive? Why?
18. Where does sleep come from?
19. What makes the clouds move?
20. Why do we need water?
21. What do we dream with?
22. What does it mean to be alive?
23. Why do we have to sleep?
24. When I walk and you stand still, do the clouds move? Why?
25. Is water alive? Why?
26. Why do we dream?
27. Tell me, what is night?
28. Where do the clouds come from?
29. What is art?
30. Is the sun alive? Why?
31. What is a dream made of?
32. Are the clouds at night white or black? Why?
33. Where does the wind come from?
34. Where do the stars come from?
35. Are our dreams true? Why?
36. Is a flower alive? Why?
37. Can the clouds make wind? Why?
38. Where does the sun go at night?
39. Where does the earth come from?
40. How is the wind made?

APPENDIX B

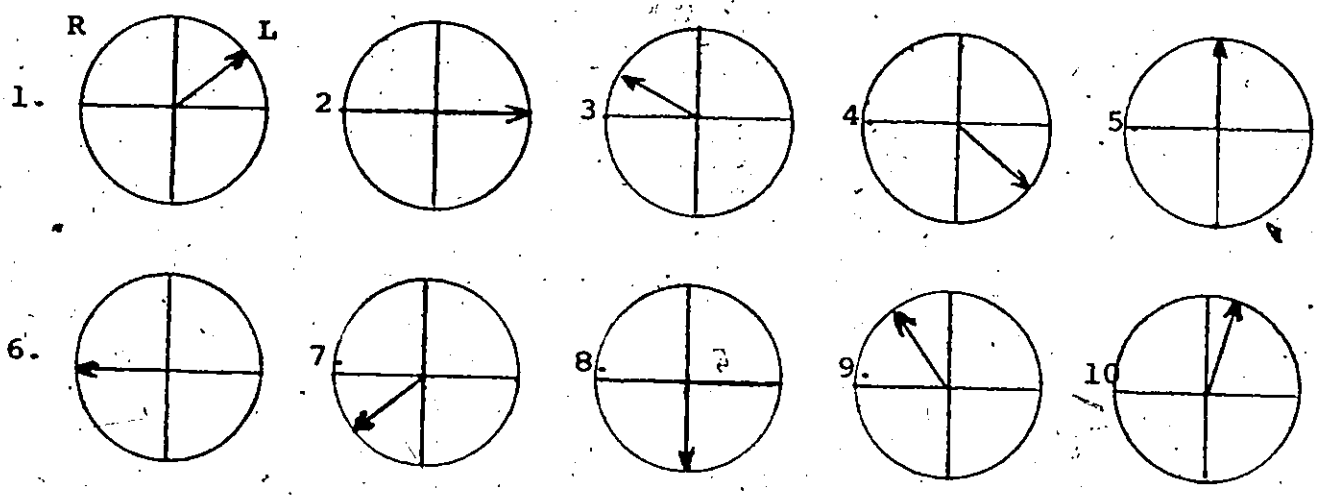
SCORING SHEET FOR RAW DATA

SCORING SHEET

Date: April 12, 1972

Subject's name: A Birth date: January 23, 1962 M/F

RL: 4 LL: 4 TOTAL: 8 UL: 5 DL: 3 TOTAL: 8



Scoring example:

Response 1: left up lateral eye movement.

" 2: left lateral eye movement.

" 3: right up lateral eye movement.

" 4: left down lateral eye movement.

" 5: upward eye movement.

" 6: right lateral eye movement.

" 7: right down lateral eye movement.

" 8: downward eye movement.

" 9: right up lateral eye movement.

" 10: left up lateral eye movement.

As can be seen from the example, the scoring of the lateral eye movement is a linear projection of the actual eye movement. This is to avoid confusion in the scoring by the experimenter. The same scoring sheet was used for head movements.

APPENDIX C

INSTRUCTIONS

INSTRUCTIONS

(Questioner to child): "Listen carefully; we would like to know more about what you think of things that happen around you. Therefore, I will ask you several questions.

I want you to look at me when I ask you the questions. Think every question over before you give me an answer. Do you understand?

Now look at me, here is the first question.....

Instructions for the questioner:

The questioner has to make sure that the child is actually looking at her every time she asks a question. Therefore, memorize the question and look at the child when you ask the question. When the child tends to give the response immediately, remind him (her) to think the question over before giving an answer.

Try to let the child feel at ease during the whole questioning period.

APPENDIX D

TEST OF DOMINANCE

TEST OF DOMINANCE

Hand

Show me how you:

1. throw a ball
2. hammer a nail
3. cut with a knife
4. turn a door knob
5. use scissors
6. use an eraser
7. write your name

Eye

8. Show me how you look through a telescope
9. Show me how you would shoot a rifle

Foot

10. Show me how you kick a football
11. Show me how you step on a bug (insect)

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